# Protein Energy Malnutrition (PEM)

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## Introduction

- Malnutrition has been defined as "a pathological state resulting from a relative or absolute deficiency or excess of one or more essential nutrients".
  - (1) Undernutrition
  - (2) Overnutrition
  - (3) Imbalance
  - (4) Specific deficiency

# Protein Energy Malnutrition (PEM)

- According to World Health Organization, protein energy malnutrition (PEM) refers to "an imbalance between the supply of protein and energy and the body's demand for them to ensure optimal growth and function".
- It affects particularly the preschool children (<6 years) with its dire consequences ranging from physical to cognitive growth and susceptibility to infection.

## Undernutrition

- Undernutrition is a major health and nutrition problem in India.
- It is not only an important cause of childhood morbidity and mortality, but leads also to permanent impairment of physical and possibly, of mental growth of those who survive.
- Frequently encountered, particularly in rural poor and urban slums
- The term undernutrition encompasses stunting (chronic malnutrition), wasting (acute malnutrition) and underweight.
- Underweight is defined as having a weight below the recommended level for a specific age;
- wasting is having a weight below the recommended level for a given height;
- whereas stunting is having a height below the recommended level for a specific age.

# India - Key Indicators

		NFHS-5		NFHS-4
Indicators	(2019-21)		(2015-16)	
Child Feeding Practices and Nutritional Status of Children	Urban	Rural	Total	Total
<ol> <li>Children under age 3 years breastfed within one hour of birth<sup>15</sup> (%)</li> </ol>	44.7	40.7	41.8	41.6
<ol> <li>Children under age 6 months exclusively breastfed<sup>16</sup> (%)</li> </ol>	59.6	65.1	63.7	54.9
<ol> <li>Children age 6-8 months receiving solid or semi-solid food and breastmilk<sup>16</sup> (%)</li> </ol>	52.0	43.9	45.9	42.7
<ol> <li>Breastfeeding children age 6-23 months receiving an adequate diet<sup>16, 17</sup> (%)</li> </ol>	11.8	10.8	11.1	8.7
<ol> <li>Non-breastfeeding children age 6-23 months receiving an adequate diet<sup>16, 17</sup> (%)</li> </ol>	14.2	12.0	12.7	14.3
<ol> <li>Total children age 6-23 months receiving an adequate diet<sup>16, 17</sup> (%)</li> </ol>	12.3	11.0	11.3	9.6
<ol> <li>Children under 5 years who are stunted (height-for-age)<sup>18</sup> (%)</li> </ol>	30.1	37.3	35.5	38.4
<ol> <li>Children under 5 years who are wasted (weight-for-height)<sup>18</sup> (%)</li> </ol>	18.5	19.5	19.3	21.0
<ol> <li>Children under 5 years who are severely wasted (weight-for-height)<sup>19</sup> (%)</li> </ol>	7.6	7.7	7.7	7.5
<ol> <li>Children under 5 years who are underweight (weight-for-age)<sup>18</sup> (%)</li> </ol>	27.3	33.8	32.1	35.8
85. Children under 5 years who are overweight (weight-for-height) <sup>20</sup> (%)	4.2	3.2	3.4	2.1

Nutritional Status of Adults (age 15-49 years)				
86. Women whose Body Mass Index (BMI) is below normal (BMI <18.5 kg/m <sup>2</sup> ) <sup>21</sup> (%)	13.2	21.2	18.7	22.9
87. Men whose Body Mass Index (BMI) is below normal (BMI <18.5 kg/m <sup>2</sup> ) (%)	13.0	17.8	16.2	20.2
88. Women who are overweight or obese (BMI ≥25.0 kg/m <sup>2</sup> ) <sup>21</sup> (%)	33.2	19.7	24.0	20.6
89. Men who are overweight or obese (BMI ≥25.0 kg/m²) (%)	29.8	19.3	22.9	18.9
90. Women who have high risk waist-to-hip ratio (≥0.85) (%)		55.2	56.7	na
91. Men who have high risk waist-to-hip ratio (≥0.90) (%)	50.1	46.4	47.7	na

# **Determinants of PEM**

#### Environment

- Socio-cultural factors affecting feeding practices
- Maternal nutrition
- Infection
- Gender
- Mother's literacy status
- Poverty and income
- Urban-rural difference

#### Biological

- Age
- Birth order and birth interval

#### **Health-care services**







on the following generation.

## **Measurement of Undernutrition**

- The three commonly used anthropometric indices are :
- - Weight-for-Age (WFA).
- - Length-for-Age or Height-For-Age (HFA).
- - Weight-for-Length or Weight-for-Height (WFH) .
- Each of the three nutrition indicators is expressed in standard deviation units (Z-scores) from the median of the reference population based on which undernutrition may be further classified as moderate or severe.

#### Underweight

- Underweight, based on weight-for-age, is a composite measure of stunting and wasting, and is recommended as the indicator to assess changes in the magnitude of malnutrition over time.
- This condition can result from either chronic or acute malnutrition, or both.
- An underweight child has a weight-for-age Zscore that is at least two standard deviations (-2SD) below the median in the World Health Organization (WHO) Child Growth Standards.

# Stunting

- Failure to achieve expected height/length as compared to healthy, well-nourished children of the same age is a sign of stunting.
- Stunting is an indicator of linear growth retardation that results from failure to receive adequate nutrition over a long period or recurrent adequate nutrition over a long period or recurrent infections.
- It may be exacerbated by recurrent and chronic illness.
- It is an indicator of past growth failure.
- Stunting often results in delayed psycho-social and cognitive development and poor school performance.
- A stunted child has a height-for-age Z-score that is at least two standard deviations (- 2SD) below the median for the WHO Child Growth Standards.

# Wasting

- Wasting represents a recent failure to receive adequate nutrition and may be affected by recent episodes of diarrhoea and other acute illnesses.
- Wasting indicates current or acute malnutrition resulting from failure to gain weight or actual weight loss.
- Causes include inadequate food intake, incorrect feeding practices, disease, and infection or, more frequently, a combination of these factors.
- A wasted child has a weight-for-height Z-score that is at least two standard deviations (-2SD) below the median for the WHO Child Growth Standards.

## Severe Acute Malnutrition (SAM)

- Severe acute malnutrition is defined by very low weight for- height/length (Z-score below - 3SD of the median WHO child growth standards), a mid-upper arm circumference < 115 mm, or by the presence of nutritional oedema.
- SAM increases significantly the risk of death in children under five years of age.
- It can be an indirect cause of child death by increasing the case fatality rate in children suffering from common illnesses such as diarrhoea and pneumonia.
- Children who are severely wasted are 9 times likely to die than well-nourished children.

#### Kwashiorkor and Marasmus

- Kwashiorkor and marasmus are the two different forms of protein and energy malnutrition.
- The main cause of this form of malnutrition is inadequate protein intake and low concentration of essential amino acids.
- Kwashiorkor is a severe form of undernutrition, which develops in individuals on diets with a low protein/energy ratio.
- Marasmus is the other form of malnutrition , which is caused by inadequate intake of both protein and energy.
- It is a form of severe cachexia with weight loss as a result of wasting in infancy and childhood.





FEATURES	MARASMUS	KWASHIORKOR
CLINICAL	ALWAYS P	RESENT
Muscle wasting	Obvious	Sometimes hidden by oedema and fat
Fat wasting	Severe loss of subcutaneous fat	Fat often retained but not firm
Oedema	None	Present in lower legs, and usually in face and fore arms
Weight for height	Very low	Low but may be masked by oedema
Mental changes	Sometimes quiet and apathetic	Irritable, moaning, apathetic
CLINICAL	SOMETIMES P	RESENT
Appetite	Usually good	Poor
Diarrhoea	Often (current and past)	Often (current and past)
Skin changes	Usually none	Diffuse pigmentation, sometimes 'flaky paint dermatosis'
Hair changes	Seldom	Sparse, silky, easily pulled out
Hepatic enlargement	None	Sometimes, due to accumulation of fat
BIOCHEMICAL	A SHE HE AND SHE AND A DATE	
Serum albumin	Normal or slightly decreased	Low (<3 g/100 ml blood)
Urinary urea per g creatinine	Normal or decreased	Low
Hydroxyproline/creatinine ratio	Low	Low
Plasma/amino acid ratio	Normal	Elevated

## Kwashiorkor

- Kwashiorkor is a disease marked by severe protein malnutrition and bilateral extremity swelling.
- It was previously believed to be due to protein deficiency and low levels of antioxidants
- Some factors that are consistently associated with the disease include recent weaning, recent infection (particularly measles), and disruptions in childhood (parental death, temporary home environment, poverty).

## Pathophysiology

- Kwashiorkor is characterized by peripheral edema in a person suffering from starvation.
- Edema results from a loss of fluid balance between hydrostatic and oncotic pressures across capillary blood vessel walls.
- Albumin concentration contributes to the oncotic pressure, allowing the body to keep fluids within the vasculature.
- Children with kwashiorkor were found to have profoundly low levels of albumin and, as a result, became intravascularly depleted.
- Subsequently, antidiuretic hormone (ADH) increases in response to hypovolemia, resulting in edema.
- Plasma renin also responds aggressively, causing sodium retention.
- These factors contribute to the edema.

## Kwashiorkor

- It usually starts as pedal edema, then facial edema, paraspinal and chest edema up to the association with ascitis.
- Besides edema, clinical features are almost normal weight for age, dermatoses, hypopigmented hair, distended abdomen, and hepatomegaly.
- Hair is usually dry, sparse, brittle, and depigmented, appearing reddish yellow.
- Cutaneous manifestations are characteristic and progress over days from dry atrophic skin with confluent areas of hyperkeratosis and hyperpigmentation, which then splits when stretched, resulting in erosions and underlying erythematous skin

#### Marasmus

- The term "marasmus" is inferred from the Greek word "marasmus", correlating to wasting or withering.
- Marasmus is the most frequent syndrome of acute malnutrition.
- It is due to inadequate energy intake over a period of months to years.
- Marasmus is associated with a better prognosis than kwashiorkor but it is still associated with relatively high mortality.
- The underlying social cause of marasmus in children is poverty

#### Marasmus

- It results from the body's physiologic adaptive response to starvation in response to severe deprivation of energy and all nutrients, and is characterized by wasting of body tissues, particularly muscles and subcutaneous fat, and is usually a result of severe restrictions in energy intake.
- Children younger than five years are the most commonly involved because of their increased caloric requirements and increased susceptibility to infections.
- These children appear emaciated, weak and lethargic, and have associated bradycardia, hypotension, and hypothermia.
- Their skin is xerotic, wrinkled, and loose because of the loss of subcutaneous fat, but is not characterized by any specific dermatosis

#### Marasmus

- Muscle wasting often starts in the axilla and groin, then thighs and buttocks, followed by chest and abdomen, and finally the facial muscles which are metabolically less active.
- In severe cases, the loss of buccal fat pads gives the children an aged facial aspect.
- Severely affected children are often apathetic but become irritable and difficult to console

#### Marasmic Kwashiorkor

- Marasmic kwashiorkor is represented by mixed features of both marasmus and kwashiorkor.
- Characteristically, children with marasmic kwashiorkor have concurrent gross wasting and edema.
- They usually have mild cutaneous and hair manifestations and an enlarged palpable fatty liver.

#### Assessment

- An adequate nutritional assessment includes detailed dietary history, physical examination, anthropometric measurements (including weight, length, and head circumference in younger children) using appropriate reference standards, such as the WHO standard growth charts, and basic laboratory indices if possible.
- In addition, skinfold thickness and mid-upper-arm circumference (MUAC) measurements represent a useful method for evaluating body composition

# **Early detection of PEM**

- The first indicator of PEM is under-weight for age.
- The most practical method to detect this, which can be employed even by field health workers, is to maintain growth charts.
- These charts indicate at a glance whether the child is gaining or losing weight.

# **Early detection of PEM**

- Arm circumference yields a relatively reliable estimation of the body's muscle mass, the reduction of which is one of the most striking mechanisms by which the body adjusts to inadequate energy intakes.
- Arm circumference cannot be used before the age of one year; between ages one and five years, it hardly varies.
- An arm circumference exceeding 13.5 cm is a sign of a satisfactory nutritional status, between 12.5 and 13.5 cm it indicates mild-moderate malnutrition and below 12.5 cm, severe malnutrition

#### Preventive measures

#### (a) Health promotion :

- Measures directed to pregnant and lactating women (education, distribution of supplements);
- 2. Promotion of breast-feeding;
- Development of low cost weaning foods : the child should be made to eat more food at frequent intervals;
- 4. Measures to improve family diet;
- Nutrition education Promotion of correct feeding practices;
- 6. Home economics;
- 7. Family planning and spacing of births; and
- 8. Family environment.

#### Preventive measures

- (b) Specific protection :
  - The child's diet must contain protein and energyrich foods. Milk, eggs, fresh fruits should be given if possible;
  - 2. Immunization; and
  - 3. Food fortification.

#### Preventive measures

(c) Early diagnosis and treatment :

- 1. Periodic surveillance;
- 2. Early diagnosis of any lag in growth;
- Early diagnosis and treatment of infections and diarrhoea;
- Development of programmes for early rehydration of children with diarrhoea;
- Development of supplementary feeding programmes during epidemics; and
- 6. Deworming of heavily infested children.

(d) Rehabilitation :

- 1. Nutritional rehabilitation services;
- 2. Hospital treatment; and
- 3. Follow-up care.





Day, World Health Day etc. to reverse the traditional practices of child care.

#### Summary of services provided at NRC & requirement for the same,

Type of Services	Activities	Human Besources	Infrastructure & Supplies
Treatment &	Provision of	Doctor	Drugs &
Patient management	comprehensive care for prevention & treatment of infections in children with SAM.	Nurses	equipment for the treatment of infections.
Nutritional counseling & support for inpatients	Balanced diet preparation for the children.	Cook	Kitchen with utensils & facilities.
	Provision of nutritional supplements.	Helpers.	Dining area.
		Nutritionist-cum-	
	Nutrition education to primary caregivers of children with SAM.	counselor.	Nutritional supplements & IEC materials.
Other counseling services	Couple counseling. Infant feeding. Family planning. Better hygiene practices. Immunization in time. Psychosocial care & development. Separate family counseling. Disadvantages of traditional childcare practices.	Nutritionist-cum- counselor	Facilities for integrated counseling services. Audio- visual equipments. IEC materials.

Capacity	Time management	Primary	Kitchen with
building of the	on the feeding habits	caregivers.	utensils & other
primary	of the family.	Cook	facilities.
caregivers	· ·	Helpers.	
	Preparation of low cost nutritious diet from locally available food ingredients.	Nutritionist –cum- counselor.	Audio-visual materials. Education tools like posters, flip charts.
	Improving food security through Kitchen gardening.	Helpers.	Green leafy vegetables &
	Better hygiene practices.	Helpers.	seeds.
	Psychosocial care & development through stimulating activities. Health seeking behavior.	Nutritionist –cum- counselor. Nurses. Nutritionist –cum- counselor	Stimulating toys for different age group of children. IEC materials.